REPORT NO. NADC-81188-60

DEVELOPMENT OF IMPROVED SH-3 HELICOPTER SEAT CUSHIONS

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17 JULY 1981

FINAL REPORT

NSAP AIRTASK NO. AL-5-80

Approved for Public Release; Distribution Unlimited

Prepared for
Navy Science Assistance Program (NSAP)
Naval Surface Weapons Center D-23
Silver Spring, MD 20910

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1. REPORT NUMBER: NADC-81188-60	2. GOVT ACCESSION NO.: AD-A103 484
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): DEVELOPMENT OF IMPROVED SH-3 HELICOPTER SEAT CUSHIONS.	5. TYPE OF REPORT & PERIOD COVERED: Final Report.
	6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): Dan Lorch	8. CONTRACT OR GRANT NUMBER(s):
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Aircraft and Crew Systems Technology Directorate, Naval Air Development Center, Warminster, Pa. 18974	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: NSAP Task No. AL-5-80
11. CONTROLLING OFFICE NAME AND ADDRESS: Navy Science Assistance Program (NSAP), Naval Surface Weapons Center (D-23), Silver Spring, MD 20910	12. REPORT DATE: 17 July 1981
	13. NUMBER OF PAGES: 20
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Commander, Naval Air Systems Command, Department of the Navy, Washington, DC 20361	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Seat Cushions
SH-3 Helicopter

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The proposed replacement seat cushions are made of closed cell foam and are painted with a flexible coating. Both the seat cushion and back cushion have ridges cut in the foam, and are covered with an open weave space fabric to improve air circulation. Tests indicate that these cushions provide considerable improvement in comfort, reduction of maintenance and cost.

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SUMMARY

Seat cushions currently in the SH-3 helicopters have major deficiencies; the foam is susceptable to deterioration, affecting crew personnel comfort and safety. Maintenance of the cushions is time consuming because cleaning and repair is difficult and often ineffective.

The proposed replacement seat cushions are constructed of closed cell foam which is not affected by leaking hydraulic fluid. They provide; improved comfort, reduced maintenance, auxiliary flotation, and reduced cost.

INTRODUCTION

Seat cushions currently in the SH-3 helicopters have major deficiencies which justify their immediate replacement. During routine operational use the outer and inner cushion materials are wetted by ever present leaking hydraulic fluid which eventually deteriorates the materials.

Because of this, the cushions gradually take on a large compressive set which alters the crewman's design eye reference. This limits the full accommodation of 5 to 95 percentile crewmen to properly adjust themselves in their seats. It also allows the crewman's thighs to uncomfortably press against the front edge of the seat.

There are presently four pieces comprising the cushion assembly, shown in figure 1; the seat cushion, back cushion, lumbar pad, and a crescent shaped back cushion support. The separate lumbar support and the small crescent back cushion support are usually lost and never replaced. With the back cushion support missing, the seat cushion can easily slide back in the seat bucket, resulting in less support for the thighs and further aggravates the crewman's discomfort.

The Naval Air Development Center (NAVAIRDEVCEN), was tasked to redesign the SH-3 cushions by the Navy Science Assistance Program (NSAP), under the direction of NAVAIR (AIR-03E1).

The NAVAIRDEVCEN cushions and a newly designed Coast Guard cushion set were evaluated to determine if either design provided sufficient improvement to justify retrofit.

Helicopter Antisubmarine Wing One, (HS-1), at the Naval Air Station, Jacksonville, FL, performed tests to evaluate cushion comfort and maintainability.

D I S C U S S I O N

1. SELECTION OF MATERIAL

Since the material was to be subjected to contact with hydraulic fluid and salt water the choice was to either cover the foam with a material impervious to the fluids, or use a closed cell foam. It was decided to investigate closed cell foams since the cover material might eventually be punctuated during rough service use, thus enabling the interior foam to soak up the fluids. Once fluid is within an open cell foam it is very difficult and impractical to clean.

Polyvinyl Chloride foam, (closed cell), was selected because it met all requirements except that it produces toxic fumes when burned. But since it is nonflammable, the toxic smoke is a minor compromise considering all of its other superior features. A fire intense enough to cause the crewman's cushions to smoke would not be survivable. It should also be noted that the existing SH-3 cushions are both flammable and product toxic fumes when burned.

Closed cell foams have not been used for seat cushions because of heat retention. This problem was solved by proper shaping of the cushions and selection of a suitable cover material. Various combinations of foam densities were fabricated into cushions at the NAVAIRDEVCEN. For instance, the MK IV seat cushion was constructed with a base of rigid foam and a top of softer foam. This was an attempt to make the cushions more crashworthy by minimizing rebound. However, this configuration proved too firm for comfort on long flights. The best material tested was AIREX S30.50 for both cushions (ref. table III); the properties of this foam are found in table I. Various other combinations of foams which were tested are shown in table II.

Because the SH-3 seats were not designed to be crashworthy with energy absorbing features, a decision was made not to compromise crew comfort for the slight improvement in crashworthiness obtained with stiffer foams (ref. 1, page 95-96).

2. CONFIGURATION DESIGN

It was decided to eliminate the adjustable lumbar pad and the crescent shaped back cushion support shown in figures 1 & 2. These were incorporated into the seat and back cushion. It was important to provide some contouring for comfort during long missions. Contours for both the seat and back cushions, figures 3, 4, 5 & 6, were established for a 50 percentile subject. It was assumed that the flexibility of the material would permit comfortable accommodation of other crewmen.

A one-plane, two-dimensional bench cut was utilized so that the contour would accept any equipment that the crewman might wear, such as; an anti-exposure suit, winter jacket, life preserver, survival vest, etc. Although it might be more comfortable to provide three-dimensional contouring, it would also be much more expensive and very likely not accommodate the extreme percentile crewmen. It would also cut down on natural air circulation through the cushion cover.

Since the foam material may be expected to take on a 10 to 15 percent permanent set during service use, the crewmen will be imprinting a slight three dimensional contour into the cushions. This can be expected to happen within the first year of operation. Therefore, the cushions should become even more comfortable with time.

All prototype cushions were designed at the NAVAIRDEVCEN and fabricated by the NAVAIRDEVCEN or by Custom Products, Inc. of Mooresville, NC. The cushion drawings shown in this report, figures 4, 5 & 6, are the final design; they incorporate all changes requested by HELANTISUBRON ONE (HS-1). Four modifications of material density and contour were required in order to provide an acceptable design.

3. CUSHION FINISH

In order to improve the strength properties of the cushions for tearing and abrasion they were coated with a tough, flexible paint (Flexabar Inc. Flexblend paint).

4. COVER MATERIAL

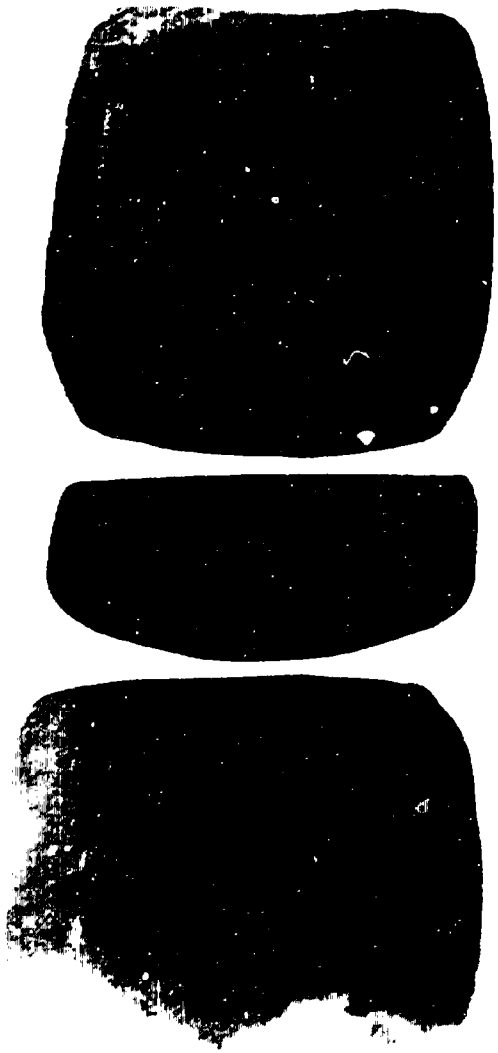
Since closed cell foam provides no air circulation, the ridges cut into the foam and the covering material were designed to permit as much natural circulation of air as possible (U.S. Navy Patent Pending).

Several types of open-weave material were tried before a selection was made of UNIROYAL TRILOCK SPACE FABRIC #6009. Since it was only necessary to cover the front surface of the cushions in contact with the crewman, a simple rectangular pattern, figures 2 & 6, was utilized which was laced on the back surface. Grommets were placed around the nylon edging tape to secure the cover to the cushions. The same rectangular cover is used for either the seat or back cushion, figures 3 & 6. This reduces the initial fabrication cost and simplifies the supply logistics since only one size cover need be stocked.

The porous cover material also simplifies the cleaning of these cushions because the covers need not be removed. It is only necessary to squirt the cushions with any all-purpose liquid detergent, then hose them off.

5. COMPATIBILITY WITH FUTURE AIRCREWMAN LIFE SUPPORT EQUIPMENT

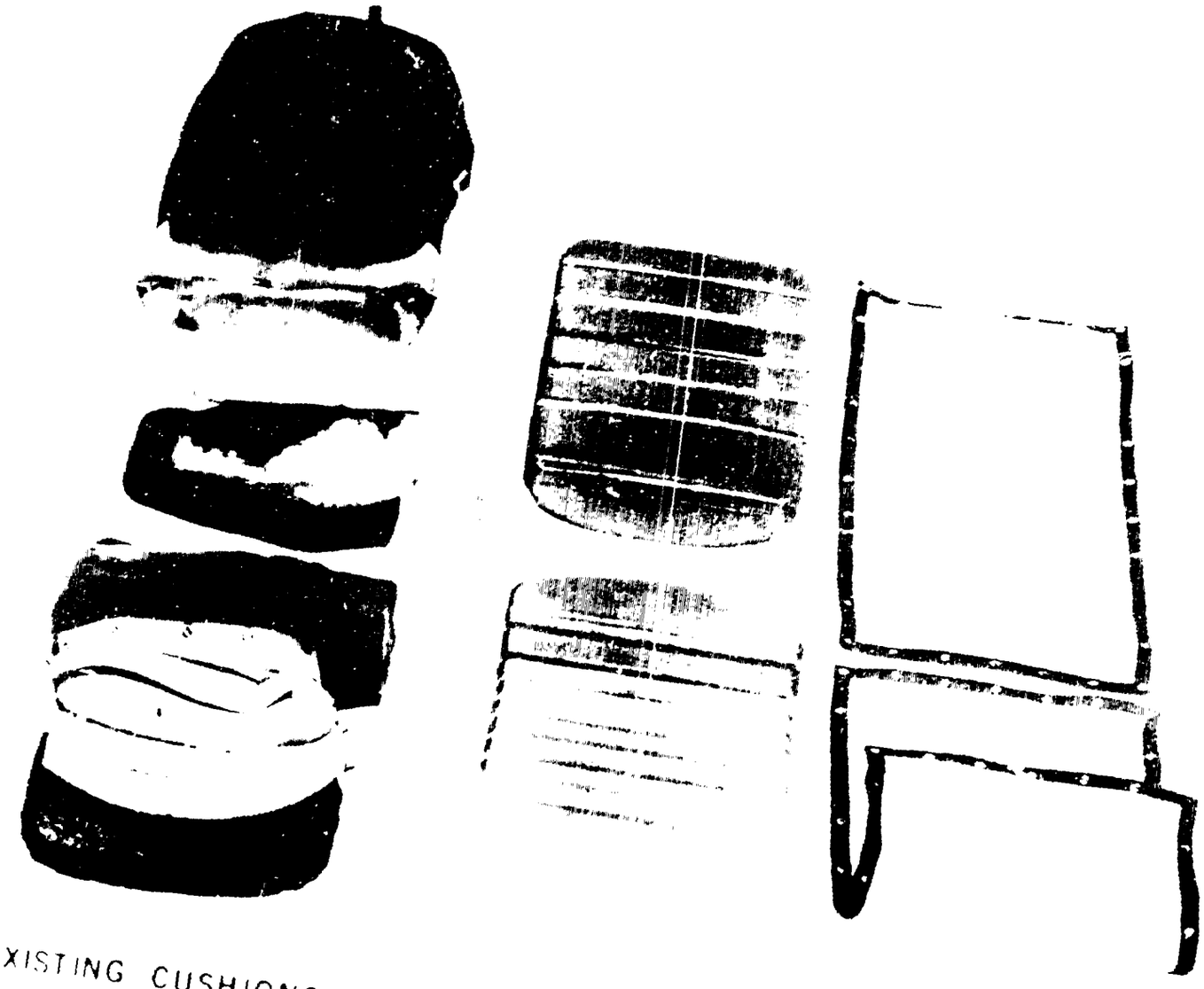
Presently, an evaluation is being made of a newly-designed, combined, survival-life vest which will have a miniraft mounted at the lumbar region of the crewman's back. If this vest is accepted, this should in no way affect the procurement of these cushions because they can easily be modified for new equipment; the foam can be recut, painted, and the same cover can be laced on top.



EXISTING CUSHIONS

PROPOSED REPLACEMENT CUSHIONS

Figure 1 - Comparison of Existing and Proposed Replacement SH-3 Cushions (Covers Or)



EXISTING CUSHIONS

PROPOSED REPLACEMENT CUSHIONS

Figure 2 - Comparison of Existing and Proposed Replacement Cushions

Figure 3 - Angled View of Proposed Replacement Cushions

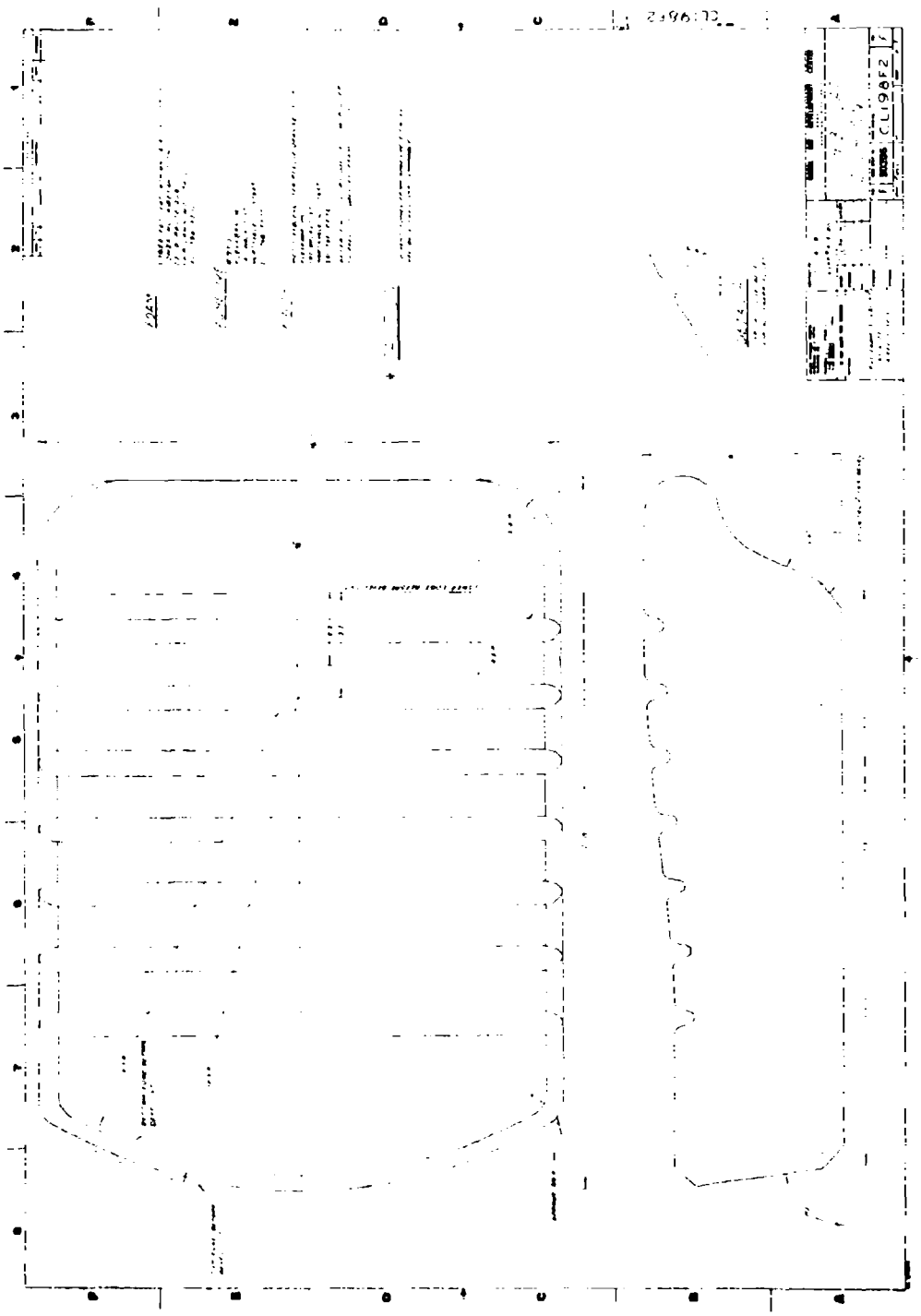


Figure 4 - Drawing - SH-3 Seat Cushion (Final Design)

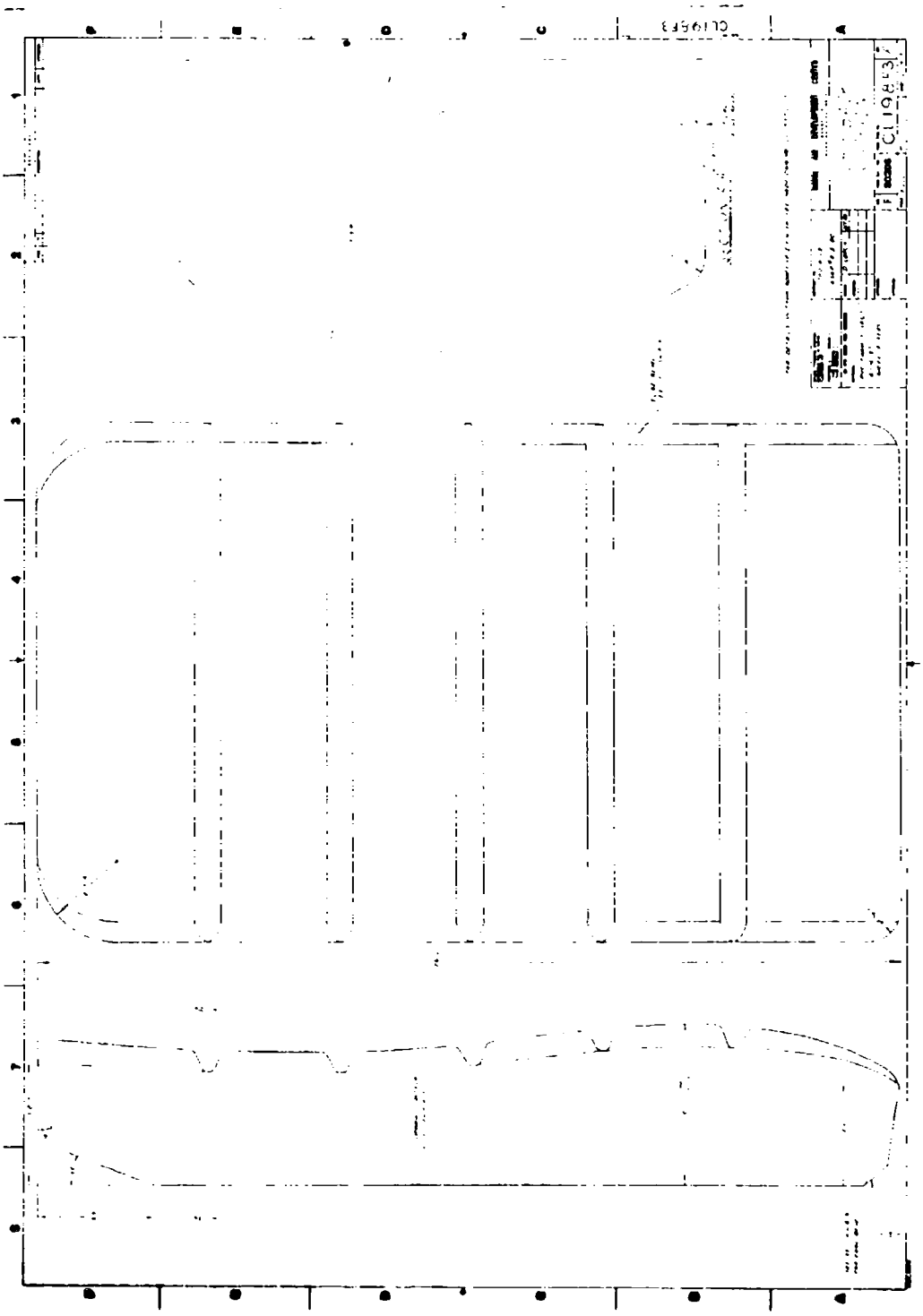


Figure 5 - Drawing - SH-3 Back Cushion (Final Design)

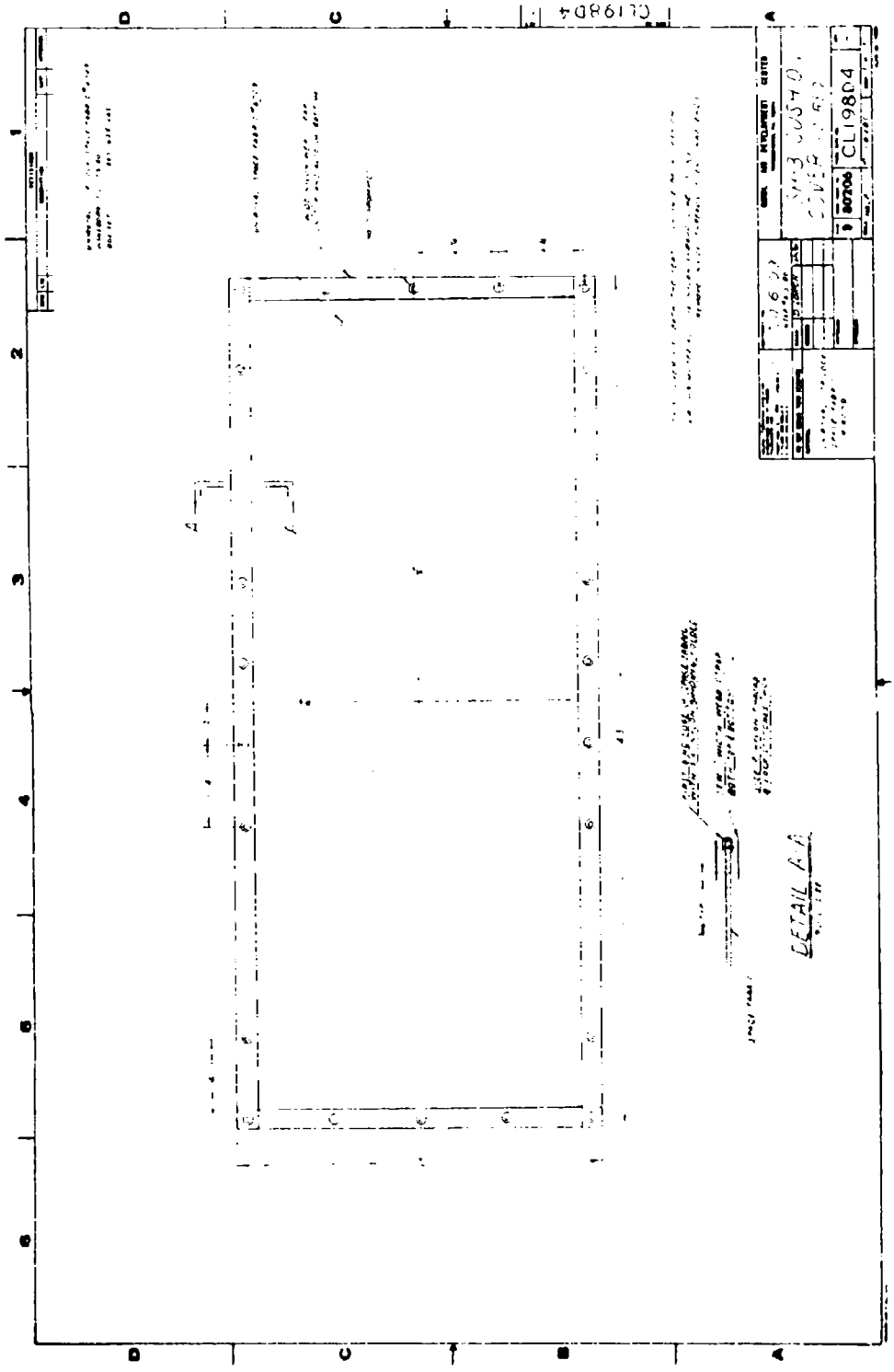


Figure 6 - Drawing - SH-3 Cushion Cover (Final Design)

TABLE I - PROPERTIES OF AIREX S 30.50 FOAM
(Foam Selected for Final Design)

AIREX is a high-quality, lightweight, closed cell, all vinyl foam with a uniformly fine cell structure that is supplied both in sheet and bun form. Its principal characteristics are unique softness and consistent quality. Resisting weather, chemicals and oil, AIREX S has a long service life. A low K factor makes AIREX S ideal for thermal insulation. Excellent buoyancy and impermeability properties qualify AIREX S as a perfect marine flotation product. AIREX S, being soft and flexible, can easily be processed and fabricated.

PROPERTY	VALUE	METHODS
Density	3.1 Lbs./cu.ft.	ASTM D-1667
Compression Resistance 25%	1.7 PSI	ASTM D-1667
Compression Set 25% 70°F., 22 H Specimen Thickness 3/4"	31%	ASTM D-1667
Tensile Strength	20 PSI	Similar to ASTM D-412
Elongation at Break	190%	
Thermal Conductivity 77°F.	.25 BTU in./sq.ft. h°F.	ASTM D-2326
Water Absorption	.05 Lbs./sq.ft.	Similar to ASTM D01667
Volume Stability	-2 to -5%	7 days 140°F.
Cold Crack	-35°F. min.	MIL-P-15280H
Flammability	40 Sec., 40 mm.	ASTM D-1692 FAA 25.853(b)

E V A L U A T I O N

1. COAST GUARD CUSHIONS

The Coast Guard cushions were considered to be too thick by all pilots. These cushions were basically the same as the existing cushions except that the foam was changed to a more rigid, slow-deforming type (Edmont-Wilson Temper Foam). Because of their open cell structure these cushions would soak up hydraulic fluid and would have to be replaced at least once a year. From a maintenance viewpoint they offer no improvement.

2. NAVAIRDEVCEN CUSHIONS

Four different prototypes of the NAVAIRDEVCEN closed cell foam cushions were evaluated and shown in table II.

TABLE II - FOAMS TESTED

MODEL #	SEAT CUSHION MATERIAL	BACK CUSHION MATERIAL
MK I	VS 300	VS 300
MK II	S 32.50	S 32.50
MK III	S 30.50	S 30.50
MK IV	2" BASE S 40.70 4" TOP S 30.50	S 30.50

FOAM DISTRIBUTORS	FOAM NUMBER
Housantonic Everfloat, Inc. 6 Bridge St., Box 529 Shelton, CT 06484	VS 300
AIREX Division Lonza, Inc. 21-00 Route 208 Fair Lawn, NJ 07410	S 32.50 S 30.50 S 40.70

TABLE III - 30-DAY EVALUATION OF CUSHIONS BY HELANTISUBRON ONE (HS-1)

	RESPONSE	MK II	MK III	MK IV
CAN YOU REACH THE CONTROLS?	YES	100%	100%	100%
	NO			
CAN YOU ADJUST FOR VISIBILITY?	YES	100%	100%	100%
	NO			
OVERALL COMFORT	EXCELLENT	4%	63%	17%
	GOOD	24%	18%	33%
	ACCEPTABLE	24%	10%	50%
	POOR	48%	9%	0%
SEAT CUSHION FIT	EXCELLENT	19%	70%	17%
	ACCEPTABLE	48%	30%	83%
	POOR	33%	0%	0%
BACK CUSHION FIT	EXCELLENT	33%	70%	0%
	ACCEPTABLE	67%	30%	100%
	POOR	0%	0%	0%
OVERALL IMPROVEMENT	MUCH	4%	64%	23%
	SOME	14%	18%	50%
	SAME	52%	18%	17%
	WORSE	30%	0%	0%
EASE OF MAINTENANCE	EXCELLENT	100%	100%	100%
	GOOD			
	FAIR			
	POOR			
NUMBER OF TEST SUBJECTS		21	11	6
TOTAL TEST TIME (HOURS)		61.5	27.6	22.5

COMMENTS FROM NAVAL MESSAGES SENT FROM HELANTISUBRON ONE;

MK I CUSHION

"The first prototype cushion was determined to be too thin and hard".

051406Z FEB81...MK II CUSHION

"Ease of maintenance is considered excellent. The majority of pilots felt the seat cushion is too firm. They complained of discomfort becoming acute after approximately three flight hours. It was additionally indicated that operating in a cold weather environment further adds to discomfort due to a perceived further increase in seat firmness. In terms of the contour or fit of the seat cushions pilots were divided with personal preference the major consideration. The design of the back cushion is considered satisfactory."

RECOMMENDATIONS;

Follow-on seat cushions be designed of a somewhat thicker and softer material. Present seat contours be retained. Present covering material be retained (both seat cushion itself and nylon mesh).

1615072 JUN81...MK III CUSHION

"Originator recommends follow-on testing and evaluation of the NAVAIRDEVCEN MK III design. The MK III constructed of lightweight, uniform density, closed celluar material, covered with an open weave nylon mesh provided the optimum in pilot comfort and support. In particular, originator strongly recommends retention of the open weave nylon seat covering, on 25 separate flights with outside air temperature in excess of 90 degrees Fahrenheit, pilots were unanimous in commenting on the ability of the cushions to reduce fatigue normally resulting from heat stress. The open weave design appears to permit air flow around the pilot's torso thereby reducing body fluid loss through perspiration."

"Originator feels final testing and eventual procurement of subject seats will enhance SH-3 operations through a significant reduction in pilot fatigue."

22 JUN81 TELEPHONE MESSAGE...MK IV CUSHION

"Too firm."

The data indicates that a cushion set similar to the MK III meets all requirements of comfort and maintainability. Figure 4, 5 & 6 show a cushion set similar to the MK III except for the back cushion which was made 3 cm thinner and with less curvature at the top (as requested by HS-1).

COST TO REPLACE SEAT CUSHIONS (1981 DOLLARS)

Information Supplied by Helicopter Squadron One (HS-1)

Cost/Aircraft/5 Years to Retain Present Cushions:

Each helicopter has 2 sets of cushions replaced/year

$106/back cushion
$150/seat cushion
$256/set

$256/set x 2 sets/year x 5 years = $2560/aircraft/5 years

Cleaning Materials:

$7/aircraft/year x 5 years = $35/aircraft/5 years

Maintenance Cost:

$3 cleanings/set/year x 1 hour/set x 2 sets/aircraft x $12 hour x 5 years = $360/aircraft/5 years

= $2560 + $35 + $360 = $2955/aircraft/5 years

Cost/Aircraft/5 Years to Replace Cushions

Each set will last 5 years or longer

$200/set

$200/set x 2 sets/aircraft/5 years = $400/aircraft/5 years

Cleaning Materials:

$5/aircraft/year x 5 years = $25/aircraft/5 years

Maintenance Cost:

6 cleanings/set/year x 5 years x hour/set x 2 sets/aircraft x $12 hour = $180/aircraft/5 years

= $400 + $25 + $180 = $605/aircraft/5 years

Total Savings/Aircraft/5 Years if New Cushions are Used

present cushions cost	$2955/aircraft/5 years
- new cushions cost	- $ 605/aircraft/5 years
savings	= $2350/aircraft/5 years

$2350/aircraft/5 years x 240 aircraft = $564,000 savings/5 years

ADVANTAGES OF REDESIGNED CUSHIONS

1. The cushion material is unaffected by hydraulic fluid, oil, and salt water.

2. The same cover pattern is used on both the seat cushion and back cushion.

3. The cushion covers need not be removed when the cushions are being cleaned. When the cushions become dirty they need only be removed from the seat, squirted with detergent, rinsed off, and dried.

4. Either the seat or back cushion will provide about 40 pounds of auxiliary flotation for the crewman.

5. They offer crash protection equal to or better than the existing cushions because they are firmer and will not bottom out.

6. If changes are made to the location of crewman life support equipment (i.e., placing a miniraft on the crewman's back), the back cushion foam can be recut, repainted, and the same cover can be replaced. This would be a very simple and economical modification if required.

7. The cushions should not need replacement for the life of the aircraft.

8. The U.S. Navy will save about $500K during the next 5 years by installing the new cushions.

CONCLUSIONS

1. Since the proposed replacement cushions will be more economical, and have been tested to be superior in comfort and maintenance compared to the present cushions, it is proposed that they be made available as soon as possible.

2. This type cushion should be considered for use in other helicopters or in any vehicle subjected to adverse environmental conditions where the cushions might be in contact with water or chemical agents (i.e., amphibious craft, jeeps, etc.).

REFERENCES

1. "Aircraft Crash Survival Design Guide Volume 1 - Design Criteria And Checklists," USARTL-TR-79-22A, December 1980.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the contributions of Dr. R. Bromberger for his diligent supervision, and Lt. Mike Callinan and Chief Don Arnette of HS-1 for coordinating the test program, and to all the aircrewmen of HS-1 who participated in the evaluation of these cushions.

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